Amaranthus parganensis (Amaranthaceae), a New Species from West Bengal, India

Saubhik Das

Taki Government College (affiliated with West Bengal State University), Taki, North 24 Parganas, PIN-743429, West Bengal, India. sbhk_das@yahoo.com

Abstract. A new species of vegetable amaranth, *Amaranthus parganensis* Saubhik Das (Amaranthaceae), has been described from the lower Gangetic Plain of West Bengal, India. Its morphology and distributional range suggest that it is related to *A. tricolor* L., both adapted to tropical climate, having a sympatric distribution and similar ecology.

Key words: Amaranthaceae, *Amaranthus*, gynomonoecy, Indo-Gangetic Plain, IUCN Red List, West Bengal.

Amaranthus L. (Amaranthaceae) is a cosmopolitan genus of herbs comprising ca. 60 to 70 species (Sauer, 1976), of which ca. 40 are native to the Americas, the rest distributed across Australia, Africa, Asia, and Europe. Most are annual weeds, and a few are valued as vegetable and ornamental amaranths. The protein-rich seeds of species such as *A. hypochondriacus* L., *A. caudatus* L., and *A. cruentus* L. are consumed as pseudocereals; these taxa are known as the grain amaranths. Sauer (1955) accepted two subgenera under genus *Amaranthus*, with *Amaranthus* subg. *Acnida* (L.) Aellen ex K. R. Robertson having dioecious species and *Amaranthus* subg. *Amaranthus* identified by its monoecious species. Traditionally, *Amaranthus* subg. *Amaranthus* has been divided into two sections, as *Amaranthus* sect. *Amaranthus* [= *Amaranthus* sect. *Amaranthotypus* Dumort.] and *Amaranthus* sect. *Blitopsis* Dumort. s.l. (Thellung, 1919; Aellen, 1959; Robertson, 1981). Carretero (1985) split *Amaranthus* sect. *Blitopsis* into two sections: *Amaranthus* sect. *Blitopsis* s. str., comprising species with indehiscent fruits, and *Amaranthus* sect. *Pyxidium* Moq., including species with dehiscent fruits. More recently, Mosyakin and Robertson (1996) recognized three subgenera on the basis of inflorescence and floral features, as *Amaranthus* subg. *Acnida*, *Amaranthus* subg. *Amaranthus*, and *Amaranthus* subg. *Albersia* (Kunth) Gren. & Godr., and moved section *Pyxidium* from subgenus *Amaranthus* to subgenus *Albersia*. All the grain amaranths, along with few weeds, are included in *Amaranthus* sect. *Amaranthus*. Vegetable amaranths are included in *Amaranthus* subg. *Albersia*, which is taxonomically complex and is currently divided into four sections: *Amaranthus* sect. *Blitopsis*, *Amaranthus* sect. *Pentamorion* (Beck) Mosyakin & K. R. Robertson, and *Amaranthus* sect. *Goerziella* (Urb.) Mosyakin & K. R. Robertson, which comprise indehiscent-fruited species, and *Amaranthus* sect. *Pyxidium*, which includes taxa with dehiscent, circumscissile utricles (Mosyakin & Robertson, 1996). Few species of *Amaranthus*, such as *A. tricolor* L., *A. blitum* L., *A. cruentus*, and *A. dubius* Mart. ex Thell. are used as leafy vegetables, but the most widely cultivated members are *A. tricolor* and *A. blitum*. *Amaranthus tricolor* is included in section *Pyxidium* and *A. blitum* is included in section *Blitopsis*. A deep red-colored, dark-seeded form of grain amaranth, *A. cruentus* is used as a leafy vegetable in tropical African and Caribbean regions. Weedy species *A. dubius*, included in *Amaranthus* nothosect. *Dubia* Mosyakin & K. R. Robertson, is often used as a green vegetable in West America and the Caribbean. Vegetable amaranths are included in *Amaranthus* sect. *Pyxidium* of subgenus *Albersia*, and this appears to be the least satisfactory taxonomic grouping within the genus. *Amaranthus tricolor* is included within *Amaranthus* sect. *Pyxidium* and is morphologically variable. Further, the morphological distinctiveness of Indian populations within *Amaranthus* are independently recognized, and a novel species is described herein.

Amaranthus parganensis Saubhik Das, sp. nov. TYPE: India. West Bengal: North 24 Parganas, Salt Lake City, EM bypass, sea level, 27 Sep. 2010, *S. Das s.n.* [specimen no. 17] (holotype, CAL; isotype, MO). Figure 1.

Species nova *Amarantho tricolori* L. affinis, sed ab eo laminae foliaris cum petiolo proportione majore, floribus hermaphroditis et pistillatis, hermaphroditis quam pistillatis multo majoribus, tepalis apice acuminatis atque fructu in tepalo longiore semper incluso distinguitur.

Robust herbs, 100–120 cm tall, appearing gynomonoecious, but not functionally; stems erect, green, branched. Leaves exstipulate, spirally arranged, blades green, ovate to lanceolate or lanceolate but not rhombic, 13–17 cm × 5–9 cm, blade apices ±

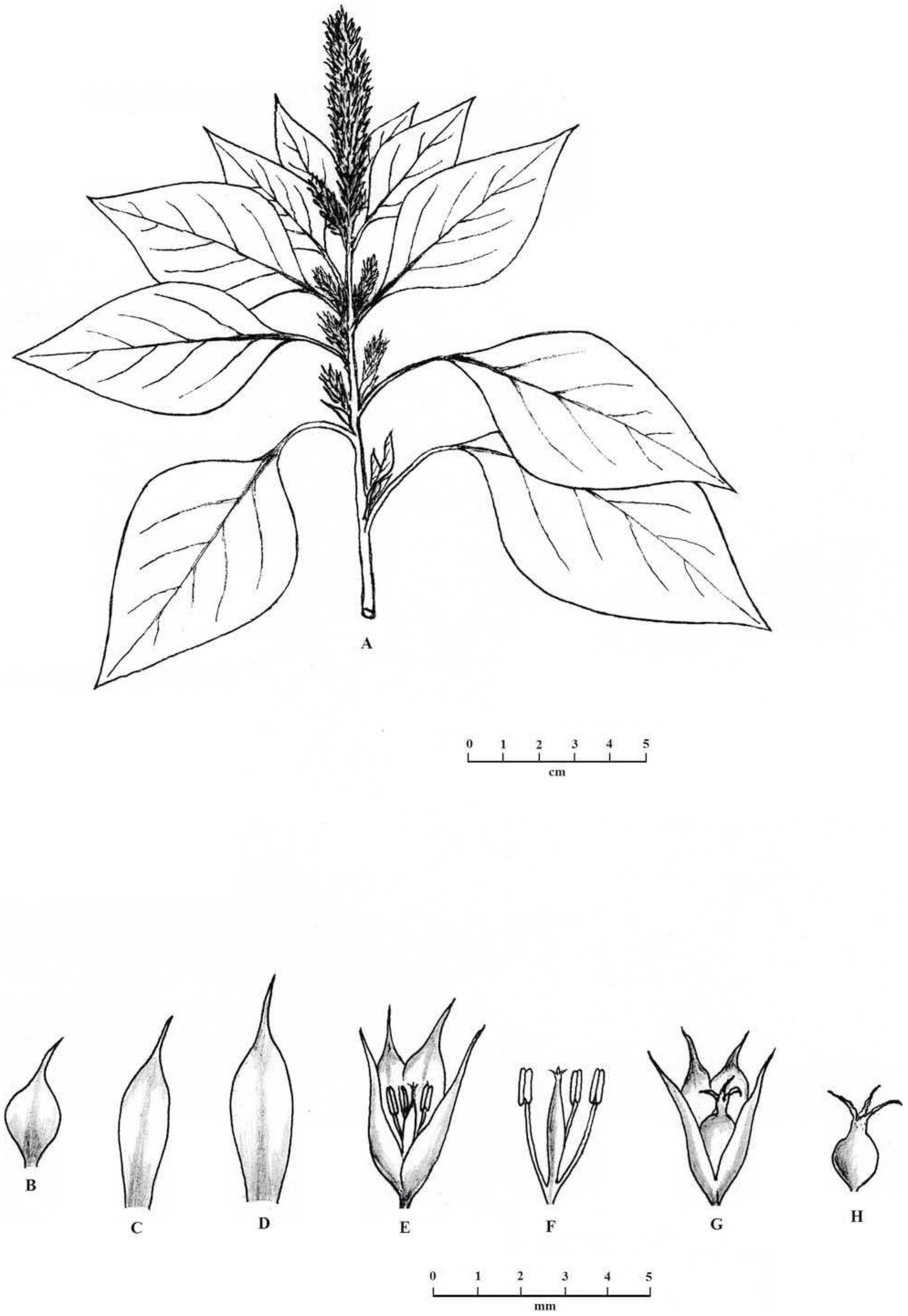

Figure 1. *Amaranthus parganensis* Saubhik Das. —A. Fertile habit. —B. Aristate bract. —C. Aristate bracteole. —D. Aristate tepal. —E. Bisexual flower. —F. Arrangement of stamens and rudimentary carpel in bisexual flower. —G. Pistillate flower. —H. Gynoecium from pistillate flower. A–H are drawn from the CAL type *Das s.n.* [17].

acute or often minutely notched, with a minute apiculum, blade bases cuneate; petioles green, 5–8 cm. Flowers in small axillary glomerules and as a terminal compound inflorescence of cymes; terminal inflorescence massive but less branched. Flowers either bisexual or pistillate, unequal in size, intermixed, ± sessile, the tepals of bisexual flowers larger than those of pistillate flowers; bracts,

bracteoles and tepals with apical awns; bracts and bracteoles broadly ovate to lanceolate, 1.5–2 mm; tepals 3, ovate to lanceolate or oblong, membranous, apex acuminate, tepal length 4.5–5 mm in bisexual flowers, 3–3.5 mm in pistillate flowers; stamens 3, free, filaments filiform, 4.5–5 mm in hermaphroditic flowers; stamens or staminodes are absent in pistillate flowers; carpels three, 2.5–3 mm, style short and thickened, ovary ovoid, stigmas 3, filiform, transparent, papillose, gynoecium in the bisexual flower with a short, thickened gynophore, gynoecium in the pistillate flower lacking a gynophore; the gynoecium rudimentary in bisexual flowers. Fruit a circumscissile utricle produced only by pistillate flowers, ovoid, 1.5–2 mm long, included by the much longer tepal, with fruit surface smooth; seeds blackish brown, shiny, compressed, 1.2–1.5 mm diam.

Distribution and habitat. *Amaranthus parganensis* occurs in the lower Gangetic Plain of West Bengal. It grows extensively in North and South 24 Parganas, and has also been collected from Hooghly, Howrah, Midnapur, Burdwan, and Nadia districts in West Bengal. The new species is cultivated as a vegetable crop and is also found in open areas. There is no previous record of this species as evident from herbarium vouchers examined by the author.

IUCN Red List category. *Amaranthus parganensis* is assessed as Data Deficient (DD), according to IUCN (2001) categories and criteria. Currently there is inadequate information to make a direct or indirect assessment of its risk of extinction based on the distribution and/or population status of the new species.

Phenology. After germination from seed, *Amaranthus parganensis* matures within 50 to 60 days as revealed from study in its natural habitat. It has been observed to flower in the months of September to October, with seeds in November to December.

Etymology. The specific epithet is taken from the Latin in reference to the geographic region where the new species grows extensively.

Discussion. The new species is assigned to *Amaranthus* subg. *Albersia*, as a vegetable amaranth. *Amaranthus parganensis* is further assigned within this subgenus to *Amaranthus* sect. *Pyxidium* due to the dehiscent utricles. Other species of vegetable amaranths growing in West Bengal, India (*A. tricolor*, *A. blitum*) are generally monoecious and are also self compatible. Breeding mechanisms in amaranths are complex and variable. The vegetable amaranths have a number of staminate flowers per glomerules and are predominantly self pollinating (Pal & Khoshoo, 1973). Vegetable amaranths are predominantly a self-pollinating crop, with varying degrees of outcrossing (Hauptli & Jain, 1985). The new species shows a structural gynomonoecy, although gynoecia are rudimentary. There is no functional gynomonoecy and no seeds were found within the rudimentary carpels of bisexual flowers. Among the three subgenera as delimited by Mosyakin and Robertson (1996), subgenus *Acnida* comprises only dioecious species, while the other two, subgenus *Albersia* and subgenus *Amaranthus*, comprise only monoecious species. There are no records of any other amaranths having gynomonoecy or incipient gynomonoecy.

In general appearance and morphology, *Amaranthus parganensis* closely resembles *A. tricolor*. Both species are distinguished by common features such as the erect habit, leaf size, bracts smaller than the tepal, and the fruit as a dehiscent, circumscissile utricle with a smooth surface and blackish brown seeds. *Amaranthus tricolor* has significant morphological variability, and some of its morphotypes have been given varietal status (Das, 2013). In India, Pan et al. (1992) studied 45 indigenous and exotic genotypes of *A. tricolor*, using 10 qualitative traits to explore differences among the genotypes. Devdas et al. (1992) found greater variability in the morphotypes of *A. tricolor* than exhibited by the morphotypes of *A. dubius*, *A. spinosus* L., and *A. viridis* L. Both *A. parganensis* and *A. tricolor* occur sympatrically, although the distribution of *A. tricolor* is much broader, cultivated as a leafy vegetable in Asia and as a green crop in Africa. Another vegetable amaranth, *A. blitum*, may be a close associate of the new species but *A. blitum* differs from the new species being a much smaller plant with smaller leaves and other differences in flower and fruit (cf. Table 1). Dispersal of the fruit and seeds of *Amaranthus* species is often performed by humans (Costea et al., 2004; Iamonico, 2010, 2012), which would obscure native distributions of these taxa.

KEY TO *AMARANTHUS* SPECIES IN WEST BENGAL, INDIA

1a. Fruit dehiscent ..... 2.
1b. Fruit indehiscent ..... 3.
2a. Monoecious, flowers unisexual ..... 4.
2b. Incipient gynomonoecious, flowers either pistillate or bisexual with rudimentary gynoecia ..... *A. parganensis* Saubhik Das

Table 1. Comparative morphology of *Amaranthus parganensis* Saubhik Das, *A. tricolor* L., and *A. blitum* L.

Morphological characteristics	*A. parganensis*	*A. tricolor*	*A. blitum*
Breeding system	incipiently gynomonoecious	monoecious	monoecious
Stems	erect, 100–120 cm	erect, 90–100 cm	erect or ascending, 35–45 cm
Leaf shape	ovate to lanceolate or lanceolate, not rhombic	deltoid ovate or ovate to lanceolate or oblong	ovate to lanceolate or rhomboid ovate
Leaf sizes	13–17 × 5–9 cm	9–17 × 5–9 cm	2.5–8 × 1.5–6 cm
Ratio of lamina to petiole lengths	2.1–2.6:1	0.89–1.66:1	0.5–1.5:1
Leaf apices	acute or minutely notched	acute or slightly emerginate	emerginate
Inflorescences	terminal inflorescence massive but less branched	terminal inflorescence massive and much branched	terminal inflorescence short
Flowers	both bisexual and unisexual; bisexual and female flowers unequal	unisexual; staminate and pistillate flowers equal	unisexual; staminate and pistillate flowers equal
Bract vs. tepal	bract < tepal	bract < tepal	bract ≤ tepal
Bract length	1.5–2 mm	1.5–2 mm	0.5–2.5 mm
Tepal shape	ovate to lanceolate or oblong	ovate to lanceolate or spathulate	lanceolate to spathulate
Tepal tip	acuminate	acute or awned	acute or obtuse
Tepal length	3–5 mm	2.25–2.5(−5) mm	1.2–2.5 mm
Fruit vs. tepal	fruit included by longer tepal	fruit may or may not exceed tepal	fruit marginally exceeding tepal
Fruit surface	smooth	smooth	faintly rugose
Fruit length	1.5–2 mm	1.5–2 mm	1.5–2.8 mm
Dehiscence	circumscissile utricle, dehiscent	circumscissile utricle, dehiscent	indehiscent
Seed diameter	1.2–1.5 mm	1.2–1.5 mm	1.1–1.8 mm
Seed color	blackish brown	blackish brown	black

3a. Stems erect or ascending; terminal inflorescence simple, short; fruit surface faintly rugose; seeds 1.1–1.8 mm diam ..... *A. blitum* L.
3b. Stems erect, terminal inflorescence complex, thyrsoid, fruit surface very rugose; seeds 1 mm diam. ..... *A. viridis* L.
4a. Staminate and pistillate flowers intermixed; stems and leaves red, reddish green or green ..... 5.
4b. Staminate and pistillate flowers not intermixed, with staminate flowers usually clustered at inflorescence apices; stems and leaves green ..... 6.
5a. Tepals 3; stamens 3; bract smaller than tepals; seeds brownish black, 1.2–1.8 mm diam. ..... *A. tricolor* L.
5b. Tepals 5; stamens 5; bract much longer than tepals; seeds black, 1 mm diam. ..... *A. hybridus* L.
6a. Presence of paired divergent spines at the nodal region; bracts ovate to lanceolate; utricle irregularly dehiscent ..... *A. spinosus* L.
6b. Absence of paired spines at nodes; bracts lanceolate; utricle circumscissile ..... *A. dubius* Mart. ex Thell.

Paratypes. INDIA. **West Bengal:** Burdwan distr., Memari, 29 Sep. 2010, *S. Das* (CAL); Hooghly distr., Arambagh, 1 Oct. 2010, *S. Das* (CAL); Howrah distr., Baksara, 3 Oct. 2010, *S. Das* (CAL); West Midnapur distr., Jhargram, 10 Oct. 2010, *S. Das* (CAL); Nadia distr., Kalyani, 15 Oct. 2010, *S. Das* (CAL); South 24 Parganas distr., Basanti, 22 Oct. 2010, *S. Das* (CAL); North 24 Parganas, Dhapa, Salt Lake, 24 Oct. 2010, *S. Das* (MO).

Acknowledgments. The author is thankful to the Central National Herbarium, Howrah, BSI, West Bengal, India, for their constant help and cooperation. Thanks are also expressed to Guy Nesom of the Flora of North America Association and to Kanchi N. Gandhi of the Harvard University Herbaria for their assistance with the Latin diagnosis.

Literature Cited

Aellen, P. 1959. *Amaranthus* L. *in* G. Hegi (editor), Illustrierte Flora von Mitteleuropa. Ed. 2, Vol. 3, Part 2. Munchen.

Carretero, J. L. 1985. Consideraciones sobre las amarantáceas ibericas. Anales Jard. Bot. Madrid 41(2): 271–286.

Costea, M., S. E. Weaver & F. J. Tardiff. 2004. The biology of the Canadian weeds 130. *Amaranthus retroflexus* L., *A. powellii* S. Watson and *A. hybridus* L. Canad. J. Pl. Sci. 84(2): 631–668.

Das, S. 2013. Infraspecific variability of *Amaranthus tricolor* (Amaranthaceae) in India with a new variety. Phytotaxa 88(2): 25–30.

Devdas, V. S., P. K. Gopaiakrishnan & K. V. Peter. 1992. Genetic divergence in vegetable amaranths. South Indian Hort. 40(1): 16–20.

Hauptli, H. & S. Jain. 1985. Genetic variation in outcrossing rate and correlated floral traits in a population of grain amaranth (*Amaranthus cruentus* L.). Genetica 66: 21–27.

Iamonico, D. 2010. Biology, life-strategy and invasiveness of *Amaranthus retroflexus* L. (Amaranthaceae) in Central Italy: Preliminary research. Bot. Serbica 34: 137–145.

Iamonico, D. 2012. *Amaranthus powellii* subsp. *Cacciatoi* comb. et stat. nov. (Amaranthaceae). Nordic J. Bot. 30(1): 12–16.

IUCN. 2001. IUCN Red List Categories and Criteria, Version 3.1. Prepared by the IUCN Species Survival Commission. IUCN, Gland, Switzerland, and Cambridge, United Kingdom. <http://www.iucn.org>.

Mosyakin, S. L. & K. R. Robertson. 1996. New infrageneric taxa and combination in *Amaranthus* (Amaranthaceae). Ann. Bot. Fenn. 33: 275–281.

Pal, M. & T. N. Khoshoo. 1973. Evolution and improvement of cultivated amaranth. VI. Cytogenetic relationship in grain types. Theor. Appl. Genet. 43: 242–251.

Pan, R. S., P. S. Sirohi & N. Sivakami. 1992. Genetic divergence in vegetable amaranths. Indian J. Hort. 49(2): 183–186.

Robertson, K. R. 1981. The genera of Amaranthaceae in the southeastern United States. J. Arnold Arbor. 62: 267–313.

Sauer, J. D. 1955. Revision of the dioecious amaranths. Madroño 13: 5–46.

Sauer, J. D. 1976. Grain amaranths. Pp. 4–7 *in* N. W. Simmonds (editor), Evolution of Crop Plants. Longman Group, London.

Thellung, A. 1919. Beitrage zur Adventivflora der Schweiz 3. Vierteljahrsschr. Naturf. Ges. Zürich 64: 684–815